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Cycling and Penile Oxygen Pressure: the Type of Saddle Matters

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Abstract

Objectives: Temporary genital numbness is a common side effect of long-distance cycling; cases of impotence have even been reported. Recent reports have shown that perineal compression leads to a decrease in penile blood flow. Reduced oxygen tension leads to penile fibrosis, which works counterproductively to the achievement of an erection. The shape of the bicycle saddle could be a factor affecting penile perfusion. The aim of this study is to find out the influence of different saddle designs on penile perfusion.

Material and Methods: In 20 healthy athletic young men (mean age 26.8 years, range 21–31 years) without history of erectile dysfunction, transcutaneous oxygen pressure (P_{tcO_2}), which correlates with arterial and tissue PO_2, was measured at the glans of the penis using a transcutaneous measurement device. All men were measured in a standing position before cycling, then during cycling in a seated position on a stationary bicycle. Four different bike saddle designs were used: (A) narrow heavily padded seat; (B) narrow seat with medium padding and a V-shaped groove in the saddle nose (''body geometry''); (C) wide unpadded leather seat; (D) women's special wide seat with medium padding and no saddle nose.

Results: During cycling in all seats a decrease in penile oxygen pressure could be observed, reflecting perineal compression. But the differences were unexpected: seat (A) mean P_{tcO_2} 11.8 mmHg, decrease in initial oxygen pressure 82.4%; seat (B) mean P_{tcO_2} 20.8 mmHg, decrease in initial oxygen pressure 72.4%; seat (C) mean P_{tcO_2} 25.3 mmHg, decrease in initial oxygen pressure 63.6%; seat (D) mean P_{tcO_2} 62.3 mmHg, decrease in initial oxygen pressure 20.3%.

Conclusions: Cycling in a seated position leads to a compression of perineal arteries with a consequent significant decrease in penile perfusion. But, there are unexpected differences between different saddle types. It was possible to demonstrate that the most important factor in safeguarding penile perfusion is not the amount of padding, but rather a saddle width which prevents sufficiently the compression of the perineal arteries.

Keywords: Cycling; Erectile dysfunction; Penile blood supply; Oxygen tension

1. Introduction

Apart from the considerable health benefits to be gained from exercise, the overzealous pursuit of fitness can also result in a number of health hazards, sometimes calling for the attention of a physician [1]. Hippocrates first reported 2500 years ago on the remarkable relationship between continuous long lasting pressure from the saddle and impotence. Of the Scythians, nomadic people famous for their horsemanship, he said that ''... the constant jolting on their horses unfits them for intercourse ...'' [2].

Today there is an intensive discussion of whether cycling is related to impotence [3–5]. A questionnaire organized by the Urological Department, in conjunction with the Sport Science Unit of the University of Cologne, revealed an overall impotence rate among amateur long-distance cyclists of 13.1%. In comparison, the impotence rate in the group of non-cyclists was 3.9% [6]. There seems to be a relationship between impotence and cycling.

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The etiology of impotence in such cases is often difficult to determine. Different factors can cause impotence. It has been shown that perineal compression during cycling decreases the penile blood flow [7]. The relationship between the corpus cavernosum trabecular structure of the penis and erectile function is dependent on a critical balance of smooth muscle to connective tissue for successful erection [8]. There has been considerable discussion regarding the role of oxygen tension in the modulation of male erectile function at the level of smooth muscle tone and on connective tissue metabolism. Hypoxemia of the penis is associated with penile fibrosis. Penile fibrosis leads to decreased penile compliance, which works counterproductively to the achievement of an erection [9].

Penile blood flow and blood pressure can be measured with spectroscopy [10], Doppler ultrasound [11], pulse-volume recording [12], arteriography [13] and by measuring the partial oxygen pressure [7]. Some hypotheses have been put forward that the shape of the saddle could have an influence on penile perfusion during cycling [1,14]. The aim of this study is to find out the influence of different saddle designs on penile perfusion, using a transcutaneous oxygen pressure measurement device. The transcutaneous partial pressure of oxygen (P_{tcO_2}) can be readily measured using non-invasive techniques that are now widely used in the management of premature infants. Several authors have shown that P_{tcO_2} levels correlate with arterial PO_2 levels [15]. Previously, it has been shown that this device is quite suitable for obtaining the P_{tcO_2} levels of the penis [7].

Fig. 1. Attachment of the electrode to the glans of the penis.

2. Material and methods

Twenty healthy athletic men with a mean age of 26.8 (range 21–31) years took part in this study. All men had experienced an erection and ejaculation in the 14 days prior to the study. None of the men were diabetic. The mean height of the men was 186 ± 5.6 cm and the mean weight was 81.6 ± 7.3 kg. Transcutaneous penile oxygen pressure was obtained using a device consisting of a modified Clark-PO_2 electrode (TCM3, TCC3, Radiometer, Copenhagen Denmark), attached to the glans of the penis. The electrode uses a thermistor-controlled heating element to keep the skin temperature at 44 °C in order to improve oxygen diffusion across the electron membrane. The electrode was attached to the glans of the penis by a single-sided adhesive ring, and a droplet of electrolyte solution placed between the membrane and skin (Fig. 1). Before measurement, a one-point calibration was made automatically. Pulse and blood pressure were automatically measured (Dinamap^{TM}, Vital Data Monitor 8100, Critikon) to demonstrate stable hemodynamic circumstances.

All men had their P_{tcO_2} measured while standing for 15 min. Then they sat and pedaled on a stationary bicycle, after 2 min reaching 60–65% of their maximum training heart rate. The aim was to keep the heart rate constantly at this level (± 5 bpm). During a period of 20 min of cycling in a seated position, the penile P_{tcO_2} was measured continuously. Transcutaneous oxygen pressure was also measured in each man over a period of 15 min post-exercise.

Four different bike saddle designs were tested (Fig. 2). We formed four groups of five men. The first group cycled on a bike saddle with a narrow seat and a heavily padded saddle nose (A). The second group used a bike saddle featuring a narrow seat with medium padding and a V-shaped groove in the saddle nose (B). The third group used a wide unpadded leather seat (C). The fourth group cycled on a special women's seat with medium padding and no saddle nose (D). In time intervals of 1 week, all groups were tested with each of the saddle designs (cross-over study).

In a pre-setting, we performed a study consisting of 15 patients to evaluate the correlation of cavernous oxygen tension to the measured oxygen tension at the glans. Blood gas samples were obtained from the corpus cavernosum before drug injection (prostaglandin E_1) and also at 2, 4, 6, 10, and 16 min following drug injection. There was 97% correlation of cavernosal PO_2 levels with the transcutaneously obtained oxygen levels (Fig. 3).

The means and standard deviations of the P_{tcO_2} measurements were calculated and significance of differences assessed using Student's *t*-test, with $P < 0.05$ considered to indicate a significant difference.

3. Results

During cycling in all seats, a significant decrease in penile oxygen pressure could be observed ($P < 0.05$), reflecting perineal compression. But the differences were unexpected, as shown in Table 1 and Fig. 4.

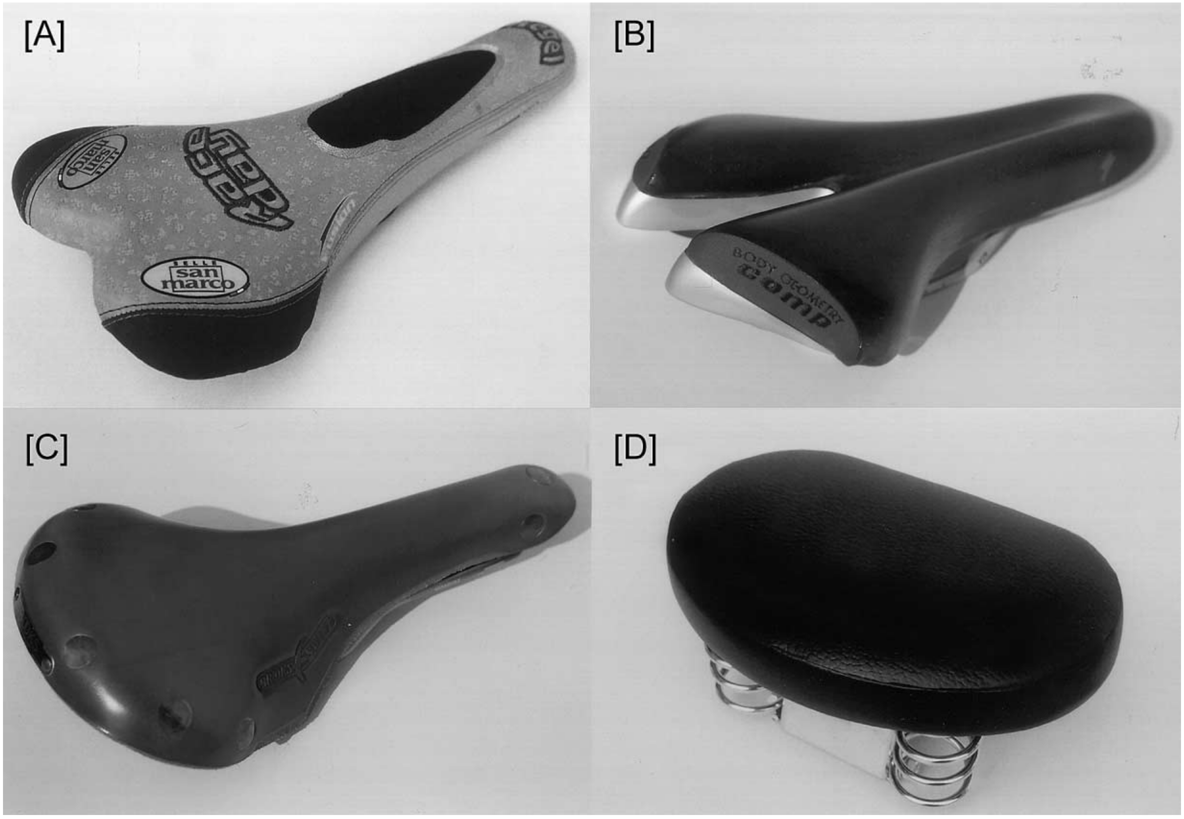

Fig. 2. Four different bicycle seats tested in the study; (A) narrow, heavily padded seat; (B) narrow seat with medium padding and V-shaped groove in the saddle nose; (C) wide unpadded leather seat; (D) women's special wide seat with medium padding and no saddle nose.

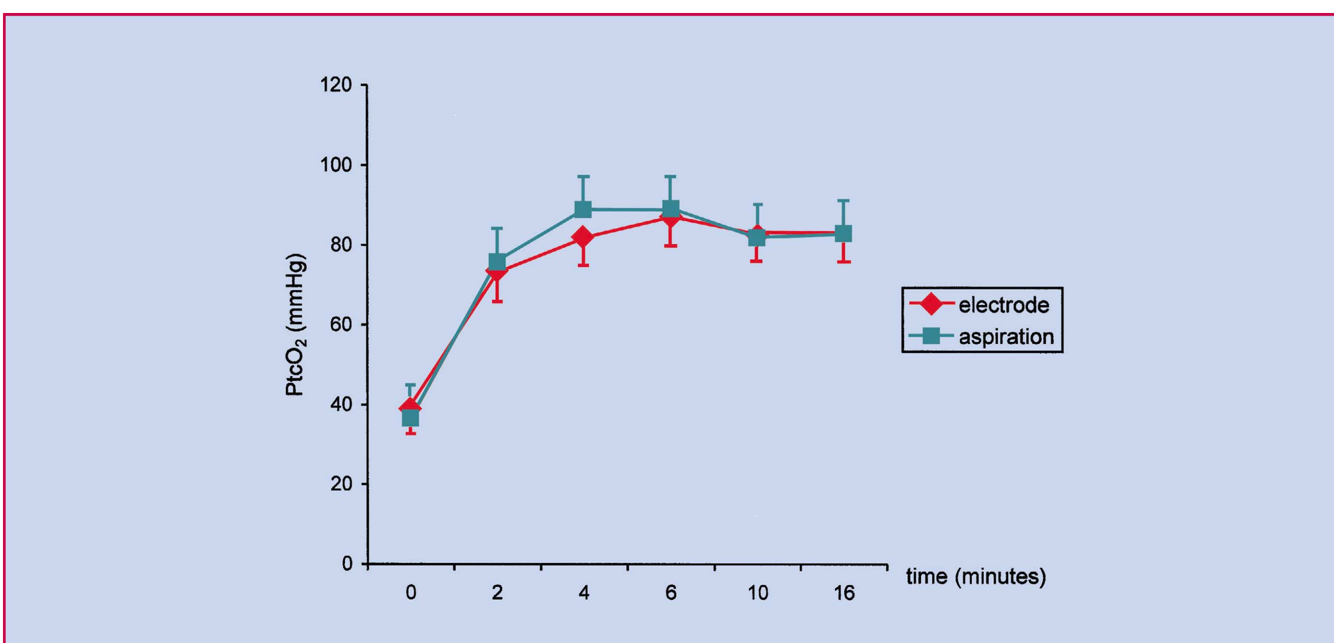

Fig. 3. Correlation of cavernosal PO_2 of 15 men, invasive (aspiration from the corpora cavernosa) vs. non-invasive (modified Clark-PO_2 electrode) during erections (after injection of 10 μg PGE_1).

Table 1
P_{tcO_2} in different bicycle seats

	Seat (A)	Seat (B)	Seat (C)	Seat (D)
Mean initial P_{tcO_2} (mmHg) ± S.D.	67.1 ± 13.8	75.4 ± 17.1	68.9 ± 18.1	78.3 ± 18.4
Mean P_{tcO_2} (mmHg) ± S.D.	11.8 ± 16.4	20.8 ± 19.5	25.3 ± 21.6	62.3 ± 20.1
P value	2.1×10^{-9}	5.1×10^{-7}	8.2×10^{-6}	1.4×10^{-2}
Decrease in initial P_{tcO_2} (%)	82.4	72.4	63.6	20.3

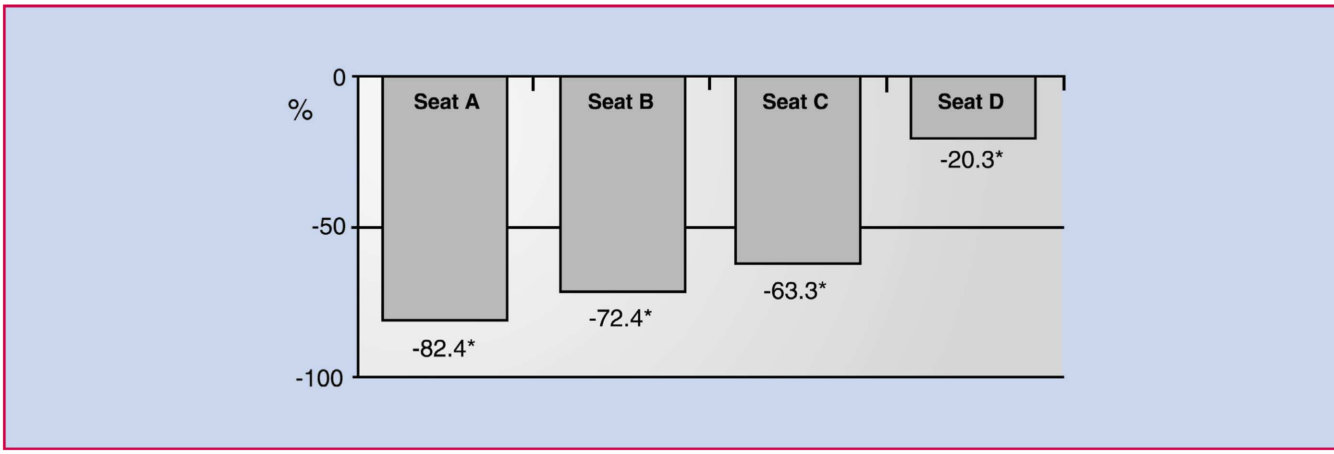

Fig. 4. Decrease in initial P_{tcO_2} in four tested bicycle seats.

With the narrow, heavily-padded seat (A), the mean P_{tcO_2} was 11.8 mmHg with a decrease in initial oxygen pressure of 82.4%. With narrow seat (B), with medium padding and V-shaped groove in the saddle nose, we observed a mean P_{tcO_2} of 20.8 mmHg and a decrease in initial oxygen pressure of 72.4%. By contrast, with the wide unpadded leather seat (C) a mean P_{tcO_2} of 25.3 mmHg was recorded with a decrease in initial oxygen pressure of only 63.6%. The best result was obtained with the special women's seat (D) with medium padding and no saddle nose with a mean P_{tcO_2} of 62.3 mmHg and a decrease in initial oxygen pressure of 20.3%.

After 10 min of recovery period in a standing position, normal penile oxygen pressure was measured in all participants.

4. Discussion

The penile arteries are terminal branches of the internal pudendal artery; this artery originates in the pelvis from the hypogastric arteries and courses through the Alcock's canal along the perineum to the root of the scrotum, where it branches into the deep and dorsal penile arteries [16,17]. Because of its course, it is subjected to trauma at various points. Kerstein et al. were the first to describe a decrease in penile perfusion during a brief period of perineal compression and were able to reveal remarkable changes in blood pressure [11]. Nayal et al. were able to establish that shifting from a seated to a standing position significantly improved the penile P_{tcO_2}, supporting the hypothesis that the perineal and penile arteries are compressed against the pubic bone by the saddle during bicycling [7].

The aim of the present study is to determine the influence of saddle design on penile perfusion using a transcutaneous oxygen pressure measurement device. Four different types of seats with various amounts of padding and different widths were tested. Cycling in a seated position in all seats led to a significant decrease in penile perfusion. Only common contemporary saddles were evaluated, but the results showed unexpected differences. Saddles (A) and (B), with heavy and medium padding, respectively, and a narrow design, showed poorer results than the wide unpadded leather seat (C), which had much less effect on penile perfusion. The least amount of change was measured with the special wide seat (D) with medium padding and no saddle nose, commonly used by women. Consequently, the most important factor in protecting penile perfusion is not the amount of padding but a saddle width which provides sufficient support to the pelvic bones and thus avoids a compression of the perineal tissue. In addition, the absent saddle nose in seat (D) prevents pinching of perineal vessels against the pubic arc. However, such an atypical design without saddle nose has little chance of acceptance in bicycle sports, e.g. long-distance cycling or trekking. Therefore, it is necessary to pay special attention to the need for sufficient rest for the bone structures and consequent relief of the sensitive perineal region, and this may only be achieved through adequate saddle width. Besides frequently changing from a seated to a standing cycling position, a more horizontal or even downward-pointing position of the saddle and restricting the training intensity when using the new ergonomically-designed bicycle seats may be the precautions necessary for preventing a decrease in penile blood flow, which could result in erectile dysfunction in long-distance cyclists.

5. Conclusions

Ergonomic saddle design with sufficient support of the perineal region represents one way to avoid a major decrease in penile perfusion. Long-term studies are required to evaluate the impact of proper positioning on the bicycle and of different saddle designs on the incidence of impotence. Meanwhile, we should bear in mind that bicycling is an important form of cardiovascular exercise. In fact, the overall vascular health of the cyclist may, in many cases, outweigh some of the local deficits that are created. Rather than give up cycling altogether, we would recommend that a cyclist use the information above to tailor his cycling program to his individual needs, body type and condition.

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